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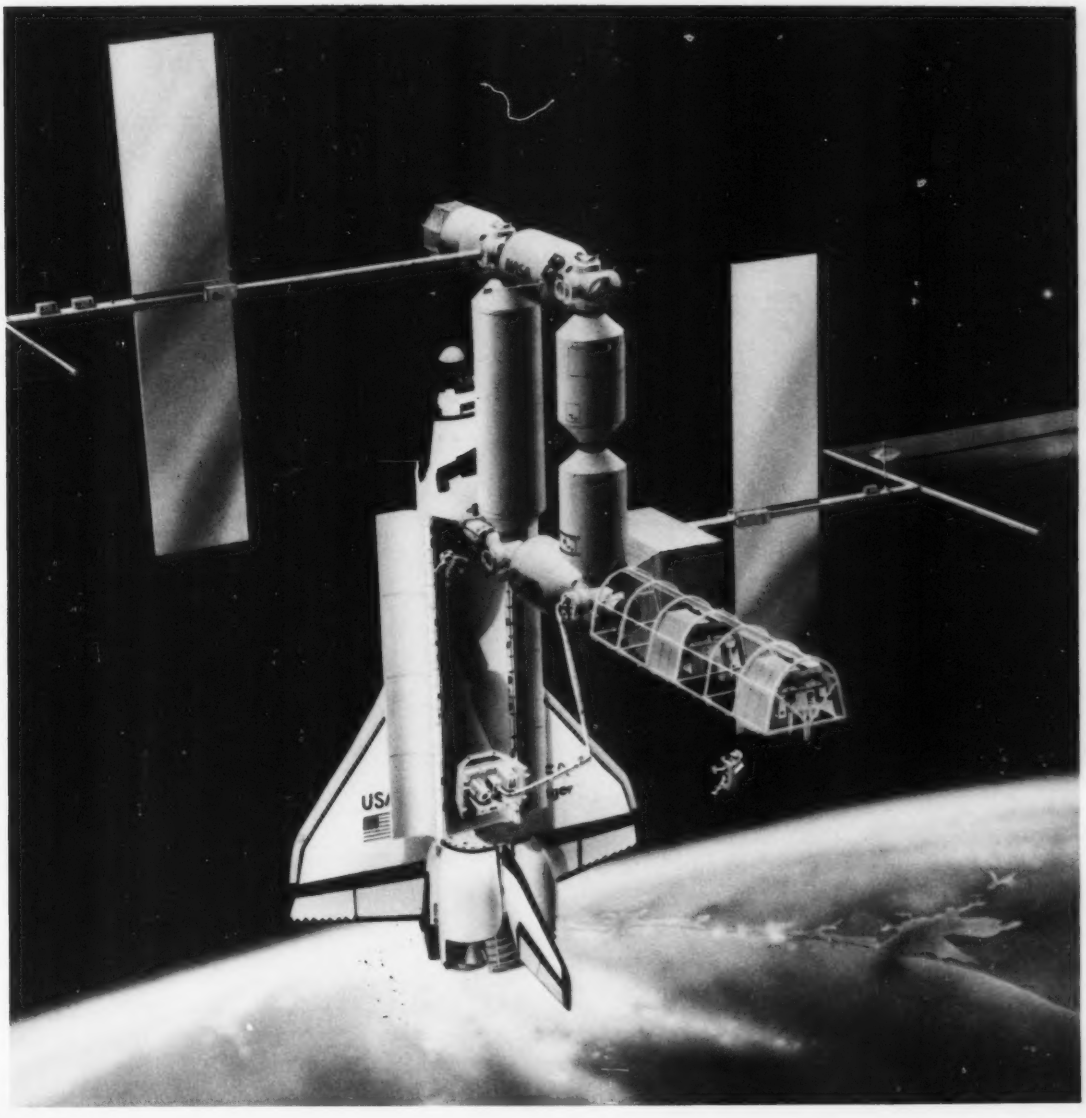

About the Cover

In 1982, with the success of the Space Shuttle, NASA began to define a Space Station for consideration by the Administration and Congress as the next major national initiative in space.

On Jan. 25, 1984, in his State of the Union address, President Reagan announced the decision to proceed with a manned, permanent Space Station.

NASA's efforts to define this station is focused upon mission requirements, technologies, systems analysis and Space Station architecture.

The cover illustration, by NASA's Lyndon B. Johnson Space Center in Houston, Texas, is one Space Station design reference configuration.

Johnson Space Center has been designated as the "lead center" for the agency's new Space Station Program.

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National Transonic Facility Dedicated

NASA's National Transonic Facility (NTF), at Langley Research Center, Hampton, Va., was dedicated Dec. 6, 1983.

The NTF is a new kind of wind tunnel that uses cryogenic (extremely cold) nitrogen gas, rather than high-pressure air, to test models of advanced design aircraft and spacecraft that will fly in or through the transonic speed range. The NTF provides far more precise design information than is now possible with conventional wind tunnels.

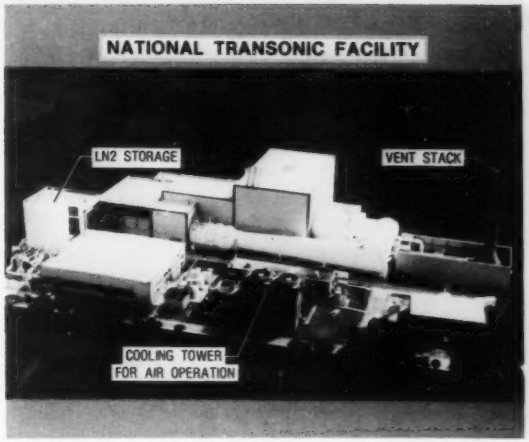
The need for this new national research facility was recognized within NASA, the Department of Defense, the U.S. aerospace industry and the scientific community. The U.S. Congress, agreeing with this assessment, authorized construction of the $85.6 million facility in the mid-1970's.

NASA and the Department of Defense (DOD) will share occupancy of the NTF about 80 percent of the time to conduct major transonic research and development programs. The remaining 20 percent of occupancy is allocated for the use of other government agencies, private industry, universities and scientific groups.

The decision to build the NTF at Langley was made after an extensive study of several possible sites, conducted by a committee representing NASA and DOD. Langley was primarily chosen because of its experienced staff of transonic aerodynamics research specialists and because of support facilities available at the Center.

A report by the DOD-NASA site selection panel referred to Langley as "one of the world's outstanding centers of excellence in transonic research . . . (it) has provided leadership in most of the important innovations and advances in understanding in this field over the past 30 years." The report also stated that an improved research facility such as the NTF is vitally needed to meet the growing demand for larger, more maneuverable, more complex and more energy-efficient aircraft.

The NTF will test aircraft designs with a research concept that was developed and proven at the Langley Research Center. Based on the adaptation of cryogenics technology (the science of producing extremely low temperatures) developed for the space program, the NTF makes possible the practical wind tunnel use of temperatures as low as 149 degrees below zero Centigrade (minus 300 degrees Fahrenheit).



The National Transonic Facility is built on the site of Langley's former Four-Foot Supersonic Pressure Tunnel. NTF uses the former tunnel's drive motor system, cooling tower, pumps, auxiliary equipment and some office space. Reuse of existing equipment and space saved about $20 million dollars in construction costs.

The NTF is operated by the Langley Research Center's Directorate for Aeronautics. Initial research programs in the tunnel are planned to improve understanding of Reynolds number and static aeroelastic effects for commerical and military aircraft. (Reynolds number is a similarity parameter used in testing aircraft models in simulated flight conditions. Reynolds number is determined by multiplying the size of an object, (e.g., a wind tunnel model) by the speed and density of gas (usually air) flowing over it, then dividing the product by the viscosity of the gas. This provides a Reynolds number that accurately relates the aerodynamic characteristics of a wind tunnel model to its full-scale counterpart.) Two "pathfinder" wind tunnel models, built to develop model criteria for the NTF, will be used in these initial research programs. Several other models have been built by private companies for future NTF test programs.

Immediate research programs planned for the National Transonic Facility include:

- Development and evaluation of aeronautical systems, including studies of components, development of aircraft configurations, and preliminary assessment and final evaluation of aerodynamic designs.
- Research and technology studies of fluid mechanics and aeroelasticity.

Spacelab 4 Payload Specialist Candidates Selected for Training

Four scientists have been named by NASA to train as payload specialist for Spacelab 4, the first Spacelab mission dedicated to Life Sciences. Spacelab 4 is scheduled to fly on Shuttle mission 61-D now set for January 1986.

Those named are: Dr. Millie Hughes Wiley Fulford, Veteran's Administration Hospital and University of California, both in San Francisco; Dr. Francis Andrew Gaffney, University of Texas Health Science Center, Southwestern Medical Center, Dallas; Dr. Robert Ward Phillips, Colorado State University, Ft. Collins; Dr. Bill Alvin Williams, Environmental Protection Agency, Corvallis, Ore.

Prior to the seven-day mission, two of the four candidates will be selected to fly on the Spacelab to conduct experiments. The other two payload specialists will serve as flight alternates and as members of the mission management and science team responsible for controlling and directing experiment operation from the ground.

The Spacelab 4 payload specialists were selected by the Investigators Working Group, consisting of the principal investigators (scientists) responsible for each of the experiments on the mission. Chairman of the IWG is NASA Mission Scientist Dr. John Rummel, Johnson Space Center, Houston. Program manager is Sterling Smith, Space Sciences and Applications Office, Washington, D.C.

Dr. Millie Hughes Wiley Fulford is currently an Assistant Professor of Biochemistry at the V.A. Medical Hospital and an associate professor at the University of California, both in San Francisco. She received her bachelor's degree from Tarleton State University, Stephensville, Texas, in 1968 and her doctorate from Texas Women's University, Denton, in 1972.

Dr. Francis Andrew Gaffney is currently an Assistant Professor of Medicine and Cardiology at the University of Texas Health Science Center, Southwestern Medical School, Dallas. He received his bachelor's degree from the University of California, Berkeley, in 1968 and his medical degree from the University of New Mexico in 1972.

Dr. Robert Ward Phillips is currently an Assistant Professor at Colorado State University, Ft. Collins. He received his bachelor's and doctor of veterinary medicine degrees from Colorado State University in 1961, and his Ph.D. from the University of California, Davis, in 1964.

Dr. Bill Alvin Williams is currently a Research Scientist/Group Leader, Toxicology, for the U.S. Environmental Protection Agency, Corvallis, Ore. He received his bachelor's degree from the University of California, Berkeley, in 1963 and his master's and doctorate from the University of Illinois in 1968.

NASA's Office of Space Science and Applications has overall responsibility for all NASA Spacelab missions. The Johnson Space Center, Houston, is the NASA center with management responsibility for the Spacelab 4 mission. Ames Research Center, Mountain View, Calif., also has responsibility for several of the experiments in the Spacelab 4 payload.

UHF-TV Stations Could Cut Power Usage In Half With Spaceage Device

A device developed originally for use in the space program is now being modified so it may directly benefit UHF television stations by significantly reducing their electrical power requirements.

The device is a compact radio wave amplifier technically called a multi-stage depressed collector. Originally developed by NASA's Lewis Research Center in Cleveland, to improve efficiencies of communications satellites, it allows more power to be utilized by the amplifying system. In space, it results in stronger signals and smaller, less-costly earth terminals.

Under a $110,000, one-year contract awarded by Lewis, Varian Inc. of Palo Alto, Calif. will adapt the multi-stage depressed collector to make it compatible with and beneficial to a similar device called a klystron.

Klystrons are vacuum electronic tubes commonly used by television stations to generate and amplify ultra-high frequencies to broadcast TV signals. Klystrons presently operate in TV transmitters at efficiencies of only about 10 to 15 percent. By modifying the klystrons to include the multi-stage depressed collectors as well as another Lewis development known as a spent beam refocuser, efficiencies of up to 30 percent can be achieved, says Lewis, with power savings on the order of 50 percent as against present use.

The energy cost savings could allow UHF broadcasters, importantly including the majority of the country's educational TV stations, several options, Lewis believes. These include improved programming, reduced need for commercial time if applicable or increased power output allowing for improvement of the signal and, thus, larger audiences.

The contract with Varian marks the beginning of a planned three-year million-dollar development effort. Financing of the project is unique in that NASA is to contribute $110,000 per year with the balance being funded by Varian Inc., the National Association of Broadcasters, and Public Broadcasting Systems. Varian Inc. is the largest manufacturer of UHF-TV klystron tubes in the United States and Canada.

A typical, large, 200,000-watt UHF television station in a medium to large metropolitan area requires about $300,000 worth of electricity per year to stay on the air.

Smaller stations servicing smaller markets require less power. By 1985, with expected fuel surcharge and inflation increases, the electric bill for all the nation's UHF broadcasters could reach $100 million.

The application of the multi-stage depressed collector to transmitter amplifier tubes now installed at UHF stations could amount to a savings of some $45 million annually beginning in 1985. Installation and equipment charges for this device are expected to pay for themselves in one year.

Ballhaus Named Director of NASA's Ames Research Center

Dr. William F. Ballhaus, Jr., has been named Director of NASA's Ames Research Center, Mountain View, Calif. He succeeds C. A. Syvertson who retired recently after a long and distinguished career of scientific achievements.

He will be responsible for providing executive leadership and direction to the Ames Research Center and its research and development programs in the fields of aeronautics, life science, space science, space technology, and flight research.

Dr. Ballhaus came to Ames in 1971, joining what is now the Army Aeromechanics Laboratory and was assigned to the Computational Fluid Dynamics Branch. In 1979, he was named Chief of the Applied Computational Aerodynamics Branch. He became Director of Astronautics in February 1980, assuming responsibility for interplanetary space flight projects, operation of a number of airborne observatories used in astronomy and earth resources research, development of supercomputer systems, research in computational fluid dynamics and computational chemistry, space science, thermophysics, and materials science.

What's New in NASA Television and Radio Programming

Programs released in January:

Television

Aeronautics & Space Report
(4½ minutes plus 90-second versions):
Space Shuttle . . . The 10th Flight

Radio

Space Story (4½-minute programs):
Free Flying in Space (featuring astronauts Bruce McCandless and Bob Stewart)
Solar Maximum Repair (featuring astronaut George Nelson)
The Galileo Mission (featuring Dr. Torrence Johnson, JPL)
Distant Galaxies (featuring Dr. Spinrad, University of California, Berkeley)

Special Report (14½-minute program):

The Tenth Space Shuttle Mission (featuring astronauts McCandless, Stewart, Gibson, McNair and Brand)

The following radio program is featured in Spanish:
El Informe Espacial

La Proxima Mision (featuring astronaut Franklin Chang-Diaz)

Copies of television tapes are sent simultaneously to all NASA Visitor Information Centers and Public Affairs Offices, and to 650 television stations nationwide as well as to 425 cable television systems via the satellite RCA-Cablenet 1. Five hundred television stations receive material formatted as a 4½-minute program; the remaining 150 stations receive a 90-second "spot"—a condensed version of the 4½-minute presentation.

NASA's radio programs are sent to approximately 3,500 radio stations across the nation; in addition, translations of the recordings are made by Voice of America and Radio Free Europe and these tapes are then released to the appropriate audiences overseas. Release each month are one report of 14½ minutes and four 4½-minute weekly stories (one story in the set is featured for one week of the month). Ten one-minute space notes are released quarterly.

Ground Control for Hubble Space Telescope Operations Dedicated

NASA's Goddard Space Flight Center dedicated the operations control center for the Hubble Space Telescope on Feb. 4.

The dedication marked the opening of what will be the key control point in receiving data from the Hubble Space Telescope and in generating commands to the spacecraft.

The Space Telescope is scheduled to be launched from the Space Shuttle in 1986. It will expand astronomers' view of the universe 350 times over what they now observe from ground-based observatories and pave the way for significant astronomical discoveries by permitting astronomers to look at objects 50 times fainter and 7 to 10 times farther away than ever seen. It will serve as the primary tool for exploring the stars through the next several decades.

The Space Telescope Operations Control Center (STOCC) integrates two major elements of Space Telescope operations into one facility, according to Dr. Noel W. Hinners, Goddard Center Director.

The Payload Operations Control Center (POCC) and the Science Support Center (SSC) represent the two functions: the POCC holding responsibility for the overall conduct of the Space Telescope's mission operations and the SSC providing the primary interface between the POCC and the user scientists at the Space Telescope Science Institute at Johns Hopkins University in Baltimore.

The POCC provides the capability for commanding and controlling the spacecraft, for monitoring the "health" and status of the spacecraft. It processes and displays the engineering data and generates, transmits, and verifies all commands to the Space Telescope.

Detailed science schedules and communications with the Space Telescope Science Institute are maintained at the SSC. It will have the capability of conducting science observations with the fine scientific instruments onboard the Space Telescope and of displaying those observations for analysis.

The facility is the largest control center for a scientific satellite to date at the Goddard Center and the most automated science scheduling system for an observatory ever. Located in an existing NASA building, the construction modifications cost less than $500,000. Cost of hardware and software, including an equipment room which houses eight computers, amounts to $31 million.

The Space Telescope Operations Control Center (STOCC) in building 3 at Goddard Space Flight Center in Greenbelt, Md., prior to its inauguration.

NASA Research Finds Aircraft Surface Grooves May Tame Turbulence

Barely visible grooves on the surface of an airplane may help to tame drag-producing air turbulence and increase fuel efficiency, NASA research has shown.

The grooves, shaped like tiny "Vs" with the angle pointing forward on the fuselage, might be no more than two-thousandths of an inch deep. But they would be deep enough, NASA thinks, to favorably alter the turbulent flow of air that forms over the surface of a moving airplane.

On today's airplane surfaces, most of the air flow is turbulent. Within this flow are violent eruptions called bursts that begin at the surface which are responsible for most of what aerodynamicists call "skin friction drag" and nearly half the total aerodynamic drag on an airplane. If the intensity of these bursts can be reduced, the reduction in drag would translate directly into lower fuel consumption or an increase in aircraft speed.

Reducing skin friction drag has been targeted by NASA's Langley Research Center, Hampton, Va., as a research goal of the 1980s, with a major focus on understanding and control of turbulent bursts.

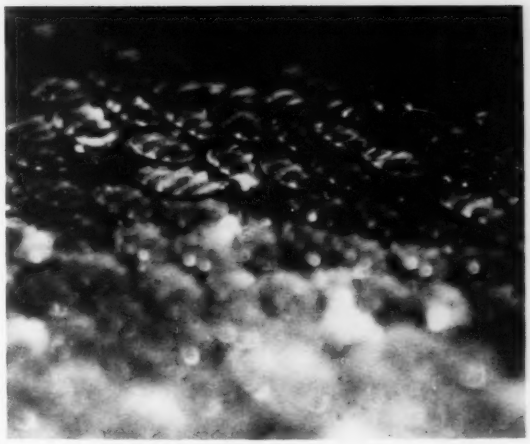
Experiments at Langley have shown that small V grooves with equal height and spacing can reduce net turbulent skin friction drag up to 10 percent, compared with ungrooved smooth surfaces. The grooves, also called "riblets," were machined into flat aluminum samples and tested in wind tunnels.

A turbulent drag reduction of 10 percent would translate to a fuel savings of about 2½ percent, a potentially hefty $200-300 million annual savings for the U.S. commercial airline fleet, estimates Jerry N. Hefner, a researcher in Langley's High-Speed Aerodynamics Division. The division's long-range goal, he says, is to double the demonstrated drag reduction to 20 percent, providing a five percent savings in fuel.

"When we change a flat smooth surface into small riblets of the size we're studying," says Hefner, "we're really talking about V-shaped valleys the size of scratches. Although these precise little grooves are small, they obviously have a pronounced effect on the turbulence and skin friction drag."

Confidence is rising that these relatively small-scale results can be repeated under flight conditions on a full-sized air transport. If the concept continues to prove itself in ground tests, the first flight test could come in 18 to 24 months.

An item published in NASA's *Tech Briefs*, a magazine devoted to transfer of technology to U.S. industry, prompted the 3M Co. of St. Paul, Minn., to design and produce test specimens of riblets in tape form. The company determined it would be simpler to take a lightweight extruded film with adhesive backing and press it into place, rather than groove the metal skin.



Close examination of the skin of a fast-swimming shark appears to confirm NASA's aerodynamically efficient riblet concept. This view, magnified 30 times, reveals that projections on the shark skin line up to form "v" grooves similar to those that have helped tame drag-producing turbulent airflows in wind tunnel tests.

In Langley tests, these grooved plastic films are reducing turbulent drag as well as, or better than, machined aluminum surfaces with the same groove sizes and shapes, reports Michael J. Walsh, principal researcher in Langley's riblet work.

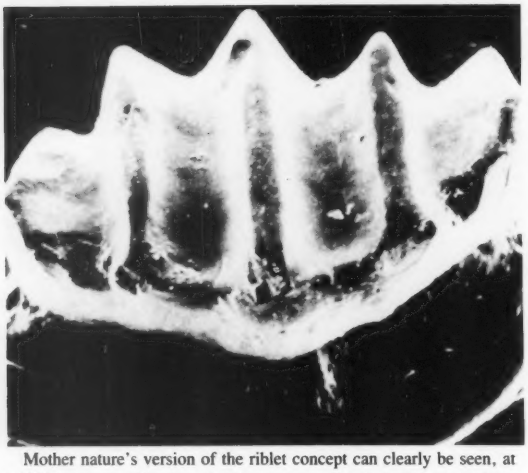
Some surface areas may not benefit from riblets. Where the flow of air over the airplane is not turbulent, a smooth ungrooved surface would be best; in highly complicated flows over wing and tail surfaces, further research is needed to determine if riblets will significantly reduce skin friction drag. Even with these exceptions, a majority of the fuselage—representing about half the area of the aircraft—remains a good candidate for riblets.

Repair of damaged riblet surfaces is not expected to be a problem on an airplane with plastic film. The old sheet would simply be pulled off and a new sheet, cut to fit, would be applied in its place. In much the same way, plastic or some similarly grooved film could be applied to existing aircraft as a relatively economical retrofit measure.

Recent observations indicate that projections on the skin of fast-swimming sharks resemble riblets. Called dermal denticles, the projections are made of the same material as shark's teeth and typically have four or five very small grooves on what looks, to the unaided eye,

like tiny flat surfaces. Slower sharks also have grooved projections, but the grooves do not line up to create the effect of continuous V grooves.

Research at Langley identified the riblet concept and its precise V shape before this clue from nature was found. The concept was derived by NASA from research indicating favorable flow characteristics of water through triangular pipes. The idea of adding sharks data came from an effort in the Soviet Union to uncover secrets from the animal world to aid in the more efficient propulsion of airplanes, ships and submarines.



Mother nature's version of the riblet concept can clearly be seen, at 3,000 times magnification, in this close-up of a shark dermal denticle. The denticles, typically with four or five grooves on the surface, are made of the same material as shark's teeth.

NASA Special Publication Issued

NASA SP-465, *The Heat Capacity Mapping Mission (HCMM) Anthology,* has been published by the Scientific and Technical Information Branch and Goddard Space Flight Center. The publication describes and illustrates information gained through measurement of the intensity of thermal infrared radiation emitted from the ground.

This book was co-authored by Nicholas M. Short and Locke M. Stuart, Jr. of Goddard Space Flight Center.

Center Libraries have copies for official use; personal copies may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 for $24.

World's Oldest, Newest Cargo Craft Cooperate

When the auxiliary power units from Space Shuttle Orbiter Challenger, America's second ultra-modern operational spaceship, had to be airlifted recently to the manufacturer for tests, the job was done by the oldest operational DC-3 in the world.

The aircraft, operated by Academy Airlines of Griffin, Ga., is a "veteran's veteran"—the sixth "Dakota" cargo airplane ever to roll off the Douglas Aircraft assembly line.

The venerable "gooney bird" also holds the honor of being the oldest aircraft ever to use the Shuttle Landing Facility runway at Kennedy Space Center in Florida.

The DC-3 was chartered from Academy Airlines to return the power units to the manufacturer, Sundstrund Corp. of Rockford, Ill. The units will undergo extensive testing.

Academy's DC-3 has logged 71,640 flying hours since leaving the Douglas factory on July 10,1936, roughly the equivalent of 8.2 years of non-stop, around-the-clock operation.

Considered one of the most versatile aircraft ever built, the twin-engine DC-3 was the standby of early airline passenger service, sometimes carrying customers part way across the country to meet railroad sleeper cars in which they continued their journey overnight.

As the tough airplane's fame spread, due in part to its exceptional stability, excellent load capacity and its ability to land and take-off from short and frequently rough runways, it quickly became a mainstay of the Army Air Corps cargo fleet. It was dubbed the C-47 by the military and affectionately renamed the "gooney bird," after the albatross. Like the bird, the DC-3 is ungainly looking on the ground, but was considered "the best friend a pilot ever had in the air" and assumed a variety of aerial roles.

The Dakota (or "Dak") flew paratroopers to their destinations, airlifted ground troops to forward positioned airstrips, carried parts to help keep combat aircraft fighting, and parachute-dropped vital frontline supplies to units in both European and Pacific theaters during World War II.

The workhorse towed combat gliders in Market-Garden, D-Day and other campaigns, and when gliders were inadequate for some loads, the C-47's engines were removed and the transport itself became a glider on occasion.

When supply lines had to be extended into virtually inaccessible Burma, "Daks" carried food, ammunition

The venerable "Gooney Bird" waits on the parking ramp of the Shuttle Landing Facility to return Space Shuttle Columbia's auxiliary power units to manufacturer after the STS-9/Spacelab mission.

and other necessities across the lofty Himalayan Mountains in a hazardous operation that came to be known as "flying the hump."

The end of World War II did not mean the end of the Dakota's military career—it served in the Berline Airlift and carried supplies to troops in Korea.

When retired by the military, hundreds of C-47s became DC-3s. Reconditioned, they began new lives, joining their civilian fellows in cargo and passenger service across North, Central and South America and all over the world.

The reliable beginning for more than one now-successful air carrier company, the Dakota still serves, earning its reputation all over again every day.

Contractor News

NASA has announced selection of **General Dynamics/Convair,** San Diego, Calif., to operate the commercial Atlas/Centaur program, subject to negotiation of a formal agreement.

Under the program, Convair, using its own resources, will build Atlas/Centaur vehicles, solicit commercial payloads, such as communications satellites, and launch them.

Until now NASA has contracted for construction of the rockets and launched commercial satellites for a fee. NASA ultimately will cease commercial operations with this launch vehicle.

NASA will begin negotiation of a formal agreement with Convair in January 1984. Convair proposes to begin marketing and production in early 1984 and to institute complete launch servics in 1987 after the last government launch.

Since the mid-1960s General Dynamics/Convair has been NASA's prime contractor for Atlas/Centaur vehicles. The Atlas booster, originally developed for the Air Force, has been used as a space launch booster since the early 1960s. The Centaur, the first cryogenic hydrogen-oxygen launch stage, was developed for NASA and has been used since the mid-1960s.

Both stages have proven their reliability—NASA has launched more than 60 with scientific, commercial and government communications payloads.

NASA's selection of Convair to operate the Atlas/Centaur program supports the Administration's policy, instituted last May, to commercialize the government's expendable launch vehicle program. Launch vehicles potentially subject to this policy include NASA's Scout, Delta and Atlas/Centaur systems and the Air Force Titan.

NASA in September 1983 formally requested proposals to commercialize its Delta and Atlas/Centaur programs. The proposal from Convair was the only one for the Atlas/Centaur program.

NASA has invited **Transpace Carriers, Inc. (TCI),** of Washington, D.C. and Greenbelt, Md., to enter into negotiations leading to the establishment of a commercial Delta launch vehicle program.

Negotiation of a preliminary agreement authorizing TCI exclusive rights to market Delta launches and to initiate commercial production of the vehicle is expected to begin in the near future.

NASA will complete its 1984 Delta launches as previously planned and TCI could begin launching in early 1985. The actual transition to commercial launch operations will be the subject of later negotiations undertaken after TCI has had the opportunity to market future launches.

Produced by McDonnell Douglas Astronautics Co., Huntington Beach, Calif., the Delta launch vehicle has been a mainstay of the U.S. space program for more than 20 years. Originally based on the USAF Thor Intermediate range ballistic missile, Delta's capability has been repeatedly upgraded by NASA. More than 170 Deltas have been launched.

Kennedy Space Center has awarded a $3,613,000 contract extension to **Modular Computer Systems, Inc.,** Fort Lauderdale, Fla., in support of Space Shuttle operations.

The company will provide minicomputers and associated equipment for the Space Shuttle's Launch

Processing System (LPS). The LPS controls and performs much of the checkout for the Shuttle vehicle automatically while the spacecraft components are being prepared for launch. It also provides the capability for work order control and scheduling, and conducts countdown and launch operations.

The new computers and equipment will support the NASA Launch Processing System at KSC, the Department of Defense's payload checkout system at KSC, and the DOD Space Shuttle launch facilities at Vandenberg Air Force Base, Calif.

The fixed-price, indefinite quantity contract extends from Jan. 1, 1984, through March 31, 1985. This action brings the total value of the contract, which was initiated in 1975, to $37,832,076.

Lewis Research Center has awarded a $14,817,680 contract to **General Dynamics Corporation, Convair Division,** San Diego, Calif., in support of the Centaur Launch Vehicles Program.

The cost-plus-award-fee contract is a follow-on contract to a current management and engineering contract for that program and will provide management and engineering services for a period beginning Jan. 1, 1984 and extending through June 30, 1985. These support activities will be carried out primarily at the Convair plant in San Diego with additional efforts at the Eastern Space and Missile Center, Fla.

These contract services will also apply to integration of the Centaur with Shuttle for assigned missions following the initial flights under a NASA development contract.

The Centaur is scheduled to fly two major missions aboard the Shuttle in 1986—Galileo to Jupiter and the International Solar Polar Mission.

Galileo Project Continues on Schedule

The Galileo Project, the nation's next major unmanned planetary exploration mission, continues on schedule toward a late May 1986 launch date.

Work on the ambitious robotic explorer is advancing at a quick pace at NASA's Jet Propulsion Laboratory in Pasadena, Calif.

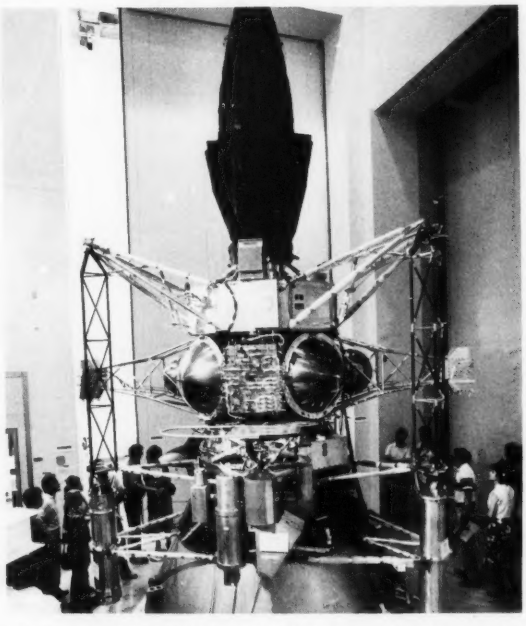
The project, named in honor of the Italian astronomer who contributed so much to man's knowledge of the planet Jupiter over 350 years ago, is the next progressive step in our investigation of the outer planets since Voyagers 1 and 2 flew past the gaseous giant globe in early 1979.

Recently, JPL employees working on Galileo, as well as a number of invited guests, viewed the full-scale development test model of the spacecraft. The event followed the most recent series of acoustic, modal and pyrotechnic shock tests performed with the spacecraft. Nearly 1,500 people took part in the open house.

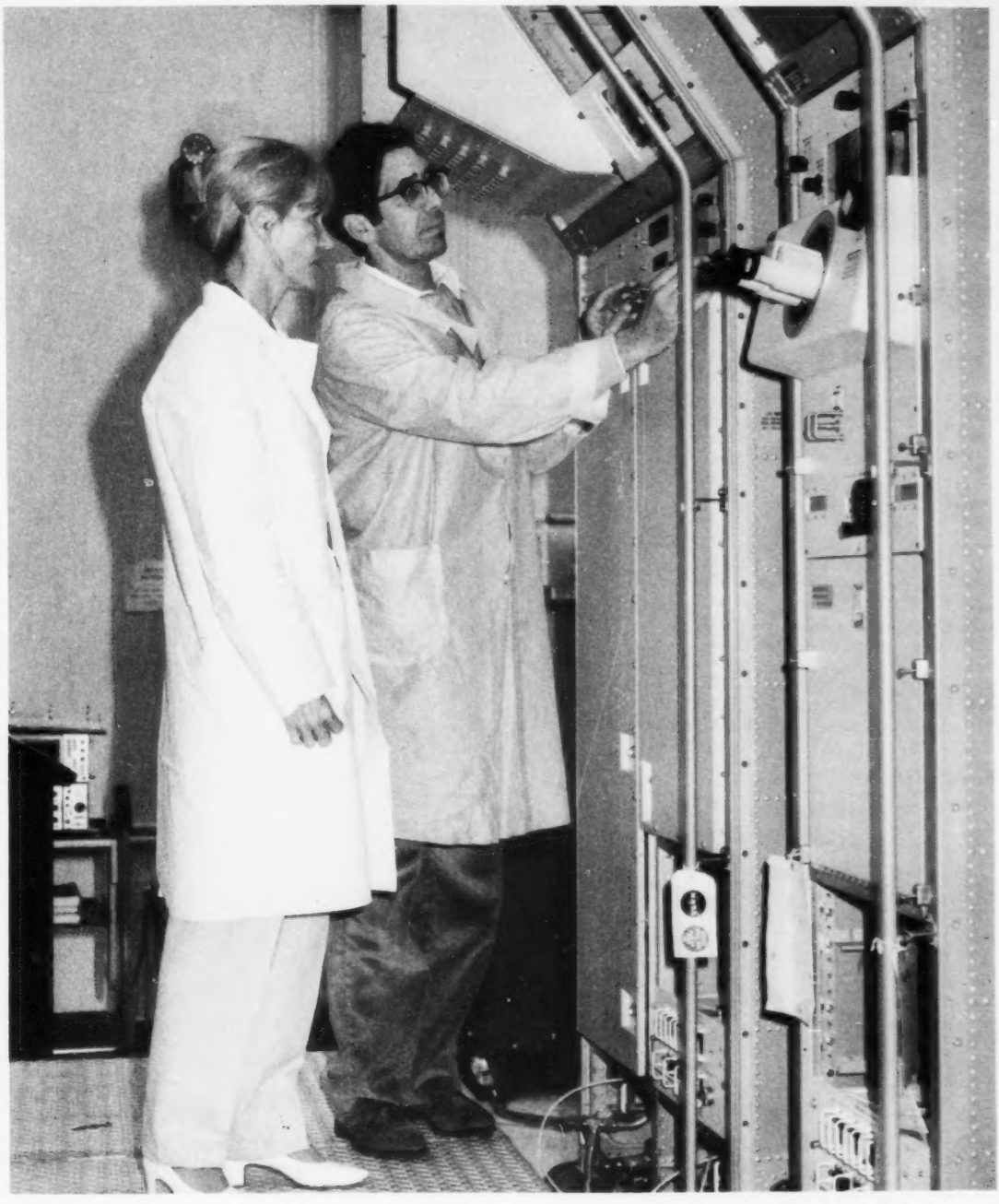
The Galileo spacecraft is slated to make a minimum of 11 circuits of Jupiter over 20 months and release an entry probe into the planet's turbulent atmosphere. It will be the first incursion into the atmosphere of an outer planet by an earth probe.

Galileo will be the first planetary mission designed specifically to use the Space Shuttle to reach earth orbit. A newly-designed Centaur G' upper stage will boost it towards Jupiter, some 500 million miles and 2¼ years away from earth.

JPL manages the Galileo Project for NASA, and is building the orbiter while Ames Research Center, Mountain View, Calif., is responsible for developing the atmospheric entry probe (built by Hughes Aircraft Co.). The retropropulsion module for Galileo is built by Messerschmitt-Boelkow-Blohm of West Germany under contract from DFVLR, and the U. S. Department of Energy is providing the two radioisotopic thermoelectric generators that will provide electrical power for Galileo. General Dynamics-Convair Division, under contract to Lewis Research Center, Cleveland, Ohio, provides the wide-bodied Centaur G' booster for the mission.



Galileo test model on display at NASA's Jet Propulsion Laboratory in Pasadena, Calif.

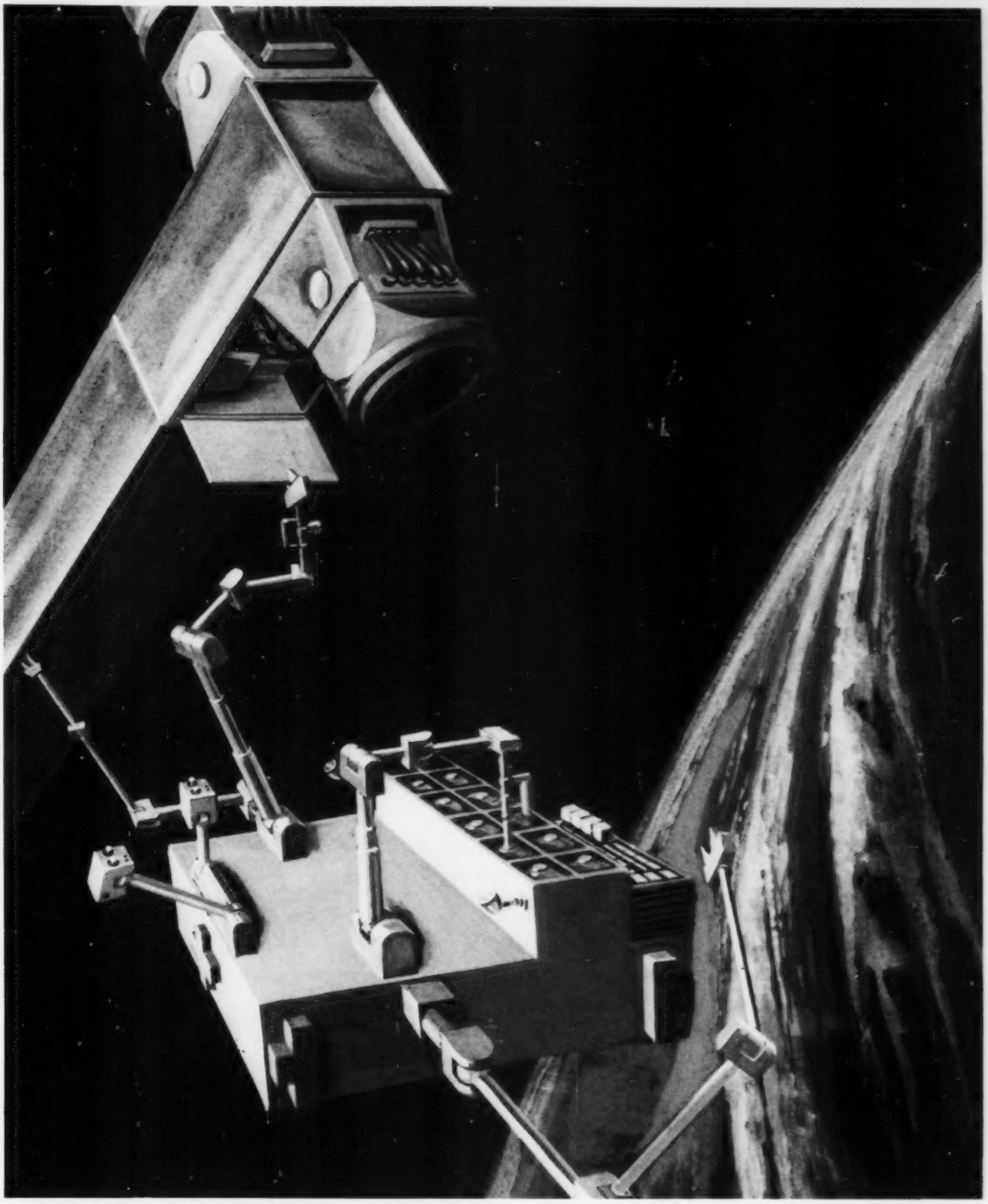


SPACELAB 3 HARDWARE TO KENNEDY SPACE CENTER—Spacelab 3 Payload Specialists Dr. Mary Helen Johnston (left) of the Marshall Space Flight Center in Huntsville, Ala., and Dr. Lodewijk van den Berg (right) of EG&G, Goleta, Calif., train on the Fluid Experiment System and the Vapor Crystal Growth System. The systems, which underwent development testing in the Marshall Center's Test Laboratory, were recently shipped to the Kennedy Space Center where the flight hardware will be integrated into Spacelab 3. The manned orbiting laboratory is scheduled for flight in November 1984.

Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces the following U.S. patents have been issued by the U.S. Patent Office and Trademark Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) & Employer	Title	Patent No.	Installation
Stanley W. Petrick, Ramon D. Garcia, Caltech/JPL, Pasadena, Calif.	Radiative cooler	4,423,605	NRO-JPL
Frank Hohl, Willard R. Weaver, Ja H. Lee, Vanderbilt University, Nashville, Tenn.	Solar pumped laser	4,424,592	LaRC
William A. Adams, Victor R. Reinhardt, NASA/GSFC	High stability buffered phase comparator	4,425,543	GSFC
Mark C. Lee, Caltech/JPL, Pasadena, Calif.	Contactless pellet fabrication	4,425,376	NRO-JPL
Frederick D. Calfo, Michael C. Lupton, NASA/LeRC	Micronized coal burner facility	4,425,854	LeRC
William T. Davis, NASA/LaRC	Missile rolling tail brake torque system	4,425,785	LaRC
Frank J. Nola, NASA/MSFC	Pulsed thyristor trigger control circuit	4,426,614	MSFC
Albert E. Willis, John M. Gould, Jack L. Matheney, Harrison Garrett, NASA/MSFC	D.C. to D.C. converter	4,426,678	MSFC
James L. Rand, Southwest Research Institute, San Antonio, Texas	Thin film strain transducer	4,425,808	LaRC
Thomas C. Moore, NASA/LaRC	Strain gage calibration	4,426,874	LaRC
William K. Witherow, NASA/MSFC	Method of and apparatus for double-exposure holographic interferometry	4,428,675	MSFC
E. Leon Morrisette, Dennis M. Bushnell, NASA/LaRC	Powder fed sheared dispersal particle generator	4,428,703	LaRC
Charlton W. Mann, NASA/LaRC	Rotary target V-block	4,428,122	LaRC



ARTIST'S CONCEPT OF TELEPRESENCE—A telepresence actuator reaches out to a large structure in space to repair an internal mechanism. Controlled from the ground, the multi-armed actuator would be equipped with lights, stereo television cameras, and tactile sensors to enable the earth-bound operator to perform the work just as if the operator himself were in space to do the hands-on repair. Telepresence is an exotic field of automation and robotics that has been under study at NASA's Marshall Space Flight Center in Huntsville, Ala. A telepresence device such as the one depicted in this artist's concept may be operational in the 1990s.

1984 Launch Activity

Space Shuttle Launches

Date	Mission	Orbiter	Launch Site*	Mission Remarks
Feb. 3	41-B	Challenger	KSC	Payload: SPAS-01A, Palapa B-2, Westar-VI; successful launch
April 6	41-C	Challenger	KSC	Payload: Solar Max Repair Mission; Long Duration Exposure Facility
June 4	41-D	Discovery	KSC	Payload: Telesat-I, Syncom IV-1, Large Format Camera, OAST-1; first flight of Discovery
Aug. 9	41-F	Discovery	KSC	Payload: Telstar 3-C, SBS-D, Syncom IV-2, SPARTAN-1
Aug. 30	41-G	Columbia	KSC	Payload: OSTA-3, ERBS, SPARX-1
Sept. 28	41-H	Challenger	KSC	Payload DOD mission or TDRS-B
Oct. 24	51-A	Discovery	KSC	Payload: MLS-1, Telesat-H, GAS Bridge
Nov. 21	51-B	Challenger	KSC	Payload: Spacelab 3
Dec. 17	51-C	Discovery	KSC	Payload: TDRS-B or TDRS-C, MSL-2

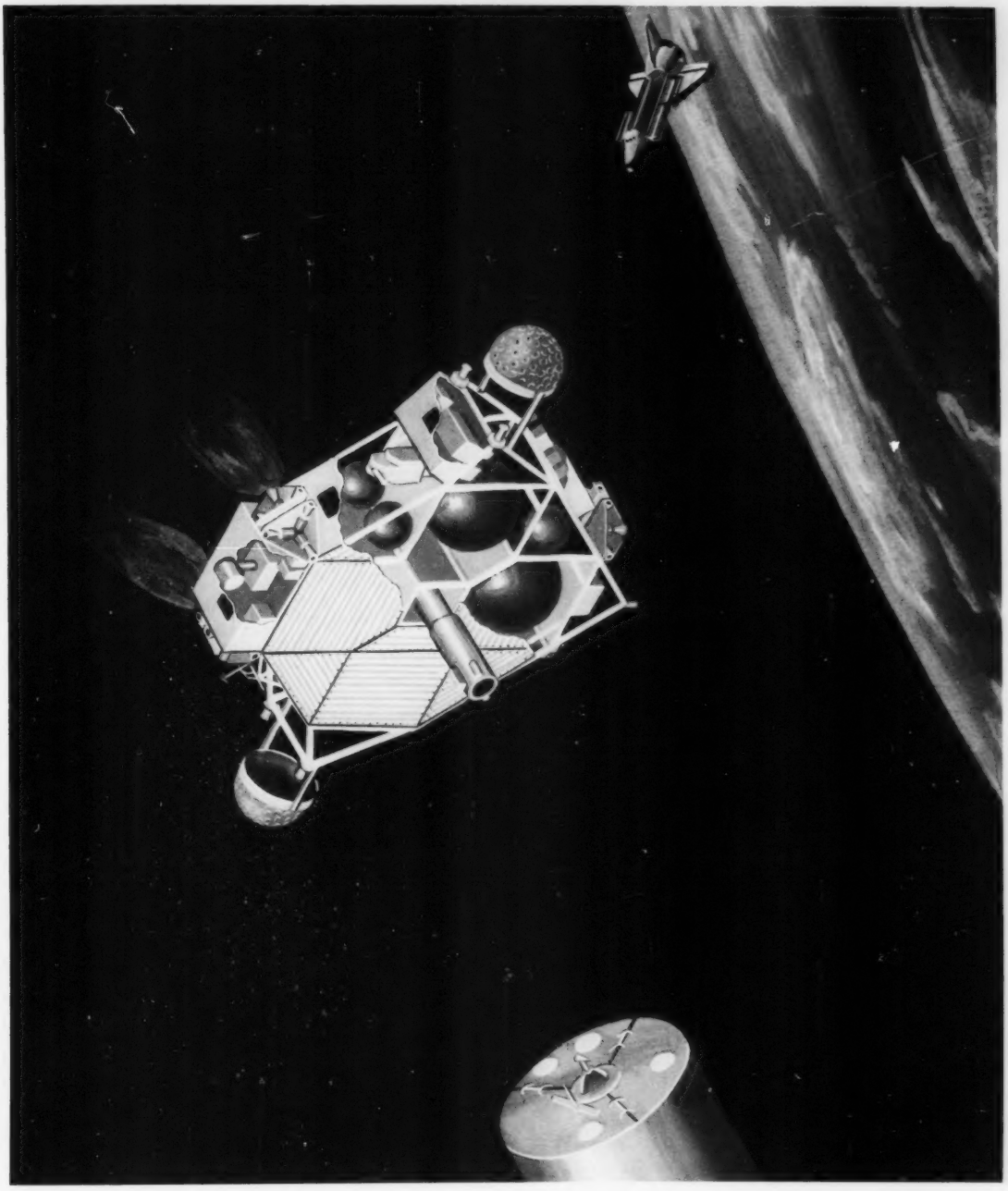
Satellite Deployments from the Space Shuttle

Date	Mission	Launch Vehicle	Launch Site*	Mission Remarks
Feb. 3	Westar-VI	PAM-D	41-B	Western Union communications; successful deployment from STS 41-B; satellite failed to achieve geosynchronous orbit
Feb. 6	Palapa B-2	PAM-D	41-B	Indonesia communications; successful deployment from STS 41-B; satellite failed to achieve geosynchronous orbit
June 4	Telesat-I	PAM-D	41-D	Canadian communications
June 5	Syncom IV-1		41-D	Hughes communications
Aug. 9	SBS-D	PAM-D	41-F	Satellite Business Systems commercial communications
Aug. 10	Syncom IV-2		41-F	Hughes communications
Aug. 11	Telstar 3-C	PAM-D	41-F	AT&T communications
Sept. 28	TDRS-B(?)	IUS	41-H	NASA communications
Oct. 24	Telesat-H	PAM-D	51-A	Canadian communications
Dec. 17	TDRS-B or C	IUS	51-C	NASA communications

Expendable Launches

Date	Mission	Launch Vehicle	Launch Site*	Mission Remarks
March 1	Landsat D[1]	Delta	WSMC	NOAA earth observation; reimbursable
2nd Qtr.	Navy-21	Scout	WSMC	Navy; reimbursable
May 17	Intelsat VA-A	Atlas Centaur	ESMC	Intelsat international communications; reimbursable
May 24	Galaxy-C	Delta	ESMC	Hughes commercial communications; reimbursable
August	NOAA-F	Atlas-F	WSMC	NOAA weather satellite; reimbursable
August	Intelsat VA-B	Atlas Centaur	ESMC	Intelsat international communications; reimbursable
Aug. 2	AMPTE	Delta	ESMC	Active Magnetospheric Particle Tracer Explorer; space physics—NASA cooperative with Germany
September	NATO-IIID	Delta	ESMC	North Atlantic Treaty Organization communications; reimbursable
3rd Qtr.	Navy-22	Scout	WSMC	Navy; reimbursable
November	Intelsat VA-C	Atlas Centaur	ESMC	Intelsat international communications; reimbursable
December	San Marco D/L	Scout	SMR	International cooperative with Italy
4th Qtr.	AF-16 (ITV-1)	Scout	WFF	Air Force; reimbursable

***Launch Sites:**
ESMC—Eastern Space and Missile Center, Fla.; KSC—Kennedy Space Center, Fla.; SMR—San Marco Range, Indian Ocean; Space Shuttle Orbiter Challenger: 41-B, 41-C, 41-E, 41-H, 51-B; Space Shuttle Orbiter Columbia: 41-G; Space Shuttle Orbiter Discovery: 41-D, 41-F, 51-A, 51-C; WFF—Wallops Flight Facility, Wallops Island, Va.; WSMC—Western Space and Missile Center, Vandenberg Air Force Base, Calif.



ORBITAL MANEUVERING VEHICLE—An artist's concept of an Orbital Maneuvering Vehicle, which would move satellites and other orbiting objects from place to place hundreds of miles above the earth. The vehicle would supplement the present Space Transportation System, the heart of which is the Space Shuttle. As presently envisioned, the maneuvering vehicle would be an unmanned spacecraft 15 feet in diameter and 3 feet in length. It could deliver payloads to orbits way beyond the practical reach of the Shuttle, and retrieve them as well. It would also serve as a means of reboosting satellites as their orbits gradually decayed, thus avoiding costly dedicated missions in using the Shuttle. The maneuvering vehicle is proposed by NASA for a first launch about 1990.

Another Dividend from Air and Space

NASA
National Aeronautics and Space Administration

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Weather Data Receiver

Included in the family of remote sensing satellites are those which report weather and other environmental information. For the most part, these satellites beam their signals to earth stations equipped with large antennas and elaborate data processing equipment. The resulting weather pictures are relayed via commercial telephone land lines to users, who need their own processing systems. Because of the expensive equipment required, maintenance costs and phone line charges, satellite data reception is largely limited to government agencies, meteorological organizations and large television stations or networks. To make weather pictures available to a broader user community, Northern Video Graphics, Inc., Minneapolis, Minn., has developed a low-cost satellite receiving system intended for such users as independent meteorologists, agribusiness firms, small airports or flying clubs, marine vessels and small TV stations. Called Video Fax, the system is based in part on NASA technology.

Video Fax is designed for use with certain satellites, such as the Geostationary Operational Environmental Satellite (GOES) spacecraft operated by the National Oceanic and Atmospheric Administration, the European Space Agency's Meteosat and Japan's Geostationary Meteorological Satellite. By dictum of the World Meteorological Organization, signals from satellites are available to anyone without cost. Thus, the Video Fax user can acquire signals directly from the satellite and cut out the middle man, enabling savings in telephone charges and other processing costs. The unit sells for about one-fifth the cost of the equipment used by TV stations.

Video Fax consists of a 2-meter diameter antenna (lower right) whose design is based on technology developed by Goddard Space Flight Center, Greenbelt, Md.; a receiver; a microprocessor-controlled display computer; and a video monitor (lower left). The computer stores data from the satellites and converts it to an image which is displayed on the monitor. The weather map can be preserved as signal data on tape or it can be stored in a video cassette as a permanent image.

* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.